GALILEO OBSERVATIONS OF GANYMEDE IMPACT CRATER MORPHOLOGY. C. M. Weitz[1], J. W. Head III[1], R. Pappalardo[1], G. Neukum[2], B. Giese[2], J. Oberst[2], A. Cook[2], B. Schreiner[2], R. Greeley[3], P. Helfenstein[4], C. Chapman[5], and the Galileo SSI Team. [1]Dept. of Geology, Brown University, Providence, RI 02912; [2]DLR, Inst. Planetary, D-12489 Berlin, Germany; [3]Department of Geology, Arizona State University, Tempe, AZ 85287; [4]Center for Radiophysics and Space Research, Cornell University, Ithaca, NY, 14853; [5]Southwest Research Inst., Space Sciences Dept., Boulder, CO 80302.

Introduction: We have used the Galileo G1 and G2 images to study the morphology and degradation of impact craters on Ganymede. Voyager data showed various types of craters, including craters with dark floors and ejecta [1, 2], craters with pedestal ejecta [3], and palimpsests [4]. With spatial resolutions ranging from 50 to 200 m/pixel in the Galileo images, features and details not resolvable in the Voyager images have provided new insight into the formation and evolution of craters on Ganymede. In this initial study, craters from six terrains on Ganymede have been analyzed, including Uruk Sulcus, Nippur Sulcus, Galileo Regio, Memphis Facula, Transitional Terrain, and the Marius Regio Groove Lane. In addition, stereo images of Uruk Sulcus and Galileo Regio have been used to measure depth/diameter ratios for several craters and to correlate albedo to topography. As more images are acquired on future Galileo encounters with Ganymede, we will continue to add to this crater database.

Uruk Sulcus: Craters in Uruk Sulcus are recognizable as bright rings surrounding dark interiors. The bright rings are interpreted predominantly as crater walls with rims making up a minor portion of the structures. The dark floors may be caused by grain size effects, penetration to underlying darker terrain, or impact melt. There is no evidence for extensive bright ejecta, even in morphologically sharp craters, although the largest crater observed in Uruk Sulcus (7.2 km diameter) has a large streak of dark material to the northeast and a smaller dark deposit in the south that may represent low albedo ejecta. The low albedo ejecta may represent underlying darker terrain exposed by the impact or it may reflect the low albedo of the impactor [5].

Craters in Uruk Sulcus have been grouped into three classes of degradation states: pristine, partially modified, and heavily modified. Pristine craters greater than 2 km in diameter (D) have bright central peaks and dark streaks along their walls that were most likely produced by mass wasting. Several circular craters are missing a portion of their walls and floors while the most degraded craters are irregular in shape, have relatively dark walls, and are disrupted by ridges and grooves.

Nippur Sulcus: All the smaller craters (< 5 km D) in Nippur have dark floors, just like those in Uruk Sulcus. However, the larger craters have bright floors, suggesting that the crater diameter determines the albedo of the floor in this terrain. A few of the craters show evidence for ejecta, including a crater that has a thin ejecta blanket with the same albedo as the surrounding terrain. One crater has had a portion of its wall collapse onto the floor but it cannot be determined how soon after crater formation the collapse occurred. Those craters that are partially modified still have a sharp rim but their floors have superimposed smaller craters. There are no heavily degraded craters in the Galileo images.

In contrast, the adjacent dark terrain is much more degraded with severe tectonic disruption of the craters. One 19 km diameter crater in the dark terrain is visible as small hills forming a distorted structure.

Marius Regio Groove Lane: The G2 images for this terrain cover a relatively small area and only about 20 craters are visible on the Groove Lane. However, these craters appear to be some of the youngest and most pristine of all the craters analyzed in this study. An 8 km diameter crater has a bright central peak, dark floor, partially collapsed wall, and an inner dark lobate ejecta surrounded by a bright halo [6]. The dark lobate ejecta is elongate about the crater with the long direction extending about 5-8 km in the E-W direction. The bright ejecta surrounding the darker lobate ejecta extends for another crater diameter and is quite thin because the underlying grooves are easily identifiable beneath the bright debris. A smaller crater has impacted into the western lobate ejecta, which may explain why the lobate ejecta is thickest here. A few kms to the south is a small crater with bright ejecta extending in finger-like projections. In contrast to the pristine craters in the Groove Lane, craters in the adjacent dark terrain are all tectonically disrupted and very degraded in appearance, similar to the craters in the dark terrain in the Nippur Sulcus images.

Transitional Terrain: All three crater degradation states can be identified in this terrain. In general, the smaller pristine craters have dark floors while the larger have bright. Faint bright ejecta is visible surrounding a few of the craters. The partially modified craters are very irregular and distorted in shape yet they show no evidence of tectonic disruption. All the partially degraded craters are in the southeast and probably represent secondaries from the large palimpsest visible in the Voyager images to the southeast. The heavily modified craters are more circular in appearance but are tectonically disrupted and have rims that are barely visible.

Memphis Facula: Memphis Facula is a large 350 km diameter palimpsest and a transect was imaged by Galileo data from the center to the edge of it. The terrain within the palimpsest is hummucky and bright while the adjacent darker terrain is similar to that seen at Galileo Regio. Two large craters (8 and 14 km D) are seen on the floor of Memphis Facula and have a sinuous black line around their rims that may represent inner rim bedrock. Both craters have dark, bumpy floors and bright rims that show evidence of mass wasting. A larger 28 km diameter crater to the east has terracing and mass wasting on its walls, appears moderately degraded, and has a relatively bright floor consisting of hummocks, smooth bright plains (possibly representing impact melt), and an irregular 4 km dark central pit. Two smaller craters have impacted onto the rim of this larger crater. One of these smaller craters (4.5 km D) has a pristine appearance, a dark floor, and a bright central peak. The other small crater (6.5 km D) has a hummocky bright floor and a relatively smaller central peak. At least in Memphis Facula, there is no correlation between the size of a crater and the albedo of its floor. Hence, other factors, such as terrain type and/or composition, are affecting the albedo of a crater floor in certain terrains on Ganymede.

Galileo Regio: Craters seen in Galileo Regio appear much more degraded than those in the other five terrains. The majority of craters have bright interiors and dark floors but the walls and rims are lineated and often discontinuous and many of the heavily degraded craters are only recognizable by bright hills arranged in a circular shape. Significant mass wasting has occurred in the region and may partly explain the high degradation state of the craters.

Simple/Complex Crater Transition: For each terrain, we measured the diameter of the minimum central peak crater and the maximum simple crater. In Uruk Sulcus, the transition diameter occurs at about 2 km while for the other five terrains it occurs at around 3 km. It is unclear why Uruk has a smaller transition diameter than the other terrains, although very few craters in the Uruk images were larger than 3 km in diameter so the data are limited in size distribution.

Crater Clusters and Chains: Several crater chains and clusters in the different terrains can be traced back to nearby larger craters visible in the Voyager images, indicating that they were formed as secondaries. In Uruk Sulcus, a chain of between 6-12 craters probably represent secondaries from a larger young crater located to the southwest. The crater Khepri seen in the Voyager data of Galileo Regio has several secondary crater chains visible in the Galileo data. A bright chain 18 km in length and composed of over a dozen craters with diameters <1 km has been identified in Nippur Sulcus. Finally, the most intriguing crater chain yet identified is located in the Transitional Terrain. The chain is 50 km long and extremely linear with a constant width. Only to the east where the chain begins is it possible to resolve individual craters but the rest of the chain has a continuous outer bright rim and dark floor. If the chain was produced by external processes then it may represent an impactor that broke up in a similar manner to Shoemaker-Levy but impacted at much closer spacings on the surface. There is also the possibility that the feature has an internal origin. However, recent C3 images of Callisto show similar linear chains, supporting that the chain in the Transitional Terrain formed by an impactor.

Stereo Data: Stereo profiles were taken across several craters in Uruk Sulcus and Galileo Regio. Stereo coverage in Uruk Sulcus allowed us to produce topographic profiles across craters between 1-2 km in diameter. All the craters have bowl-shaped profiles and one (2 km D) has a 30 m high central peak. In Galileo Regio, a 20 km diameter crater has an interior moat adjacent to the wall and a bowed up center, indicating that the crater experienced viscous relaxation. The smaller pristine craters (4-7 km D) have bowl-shaped profiles.

Depth/diameter values were determined for several craters in the two terrains and plotted against results from the Voyager data [7] (figure 1). The Galileo Regio values match the best fit curve for the Voyager data while the Uruk Sulcus data fall below the resolution of the Voyager results (>3 km D). However, if the Voyager curve is extended to the smaller diameters, the Uruk data fall close to the curve.

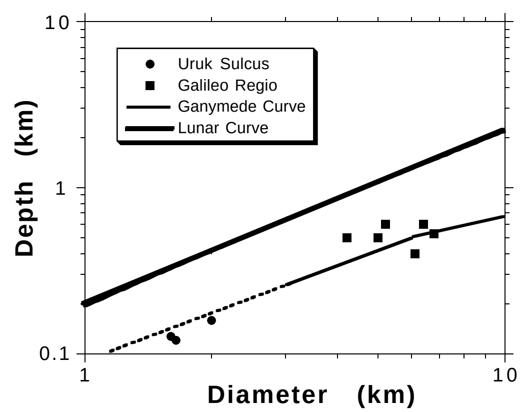

Figure 1. Plot of depth vs diameter for several craters in Uruk Sulcus and Galileo Regio. The Ganymede curve was produced by [7] using Voyager data.

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